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(54) Title of the Invention: ELECTROPHOTOGRAPHIC TONER

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Specification

1. Title of the Invention

ELECTROPHOTOGRAPHIC TONER

2. Claims

1. An electrophotographic toner which includes a binder resin comprising:

(a) 20 to 95% by weight of an uncrosslinked vinyl polymer having a weight average molecular weight of 10,000 to 50,000 and a glass transition point ranging from 40 to 80°C, and containing no gel fraction; and

(b) 80 to 5% by weight of a crosslinked polymer having a glass transition point ranging from 30 to 70°C and containing 5 to 70% by weigh of a gel fraction.

2. The electrophotographic toner according to claim 1, wherein the binder resin is obtained by melt kneading the uncrosslinked vinyl polymer and the crosslinked polymer.

3. The electrophotographic toner according to claim 1 or 2, wherein the uncrosslinked vinyl polymer and the crosslinked polymer each contains 40% by weight or more of styrene as a polymer constituent.

3. Detailed Description of the Invention

(Industrial Field of Application)

The present invention relates to a toner for developing

an electrostatic charge image which is formed on a photoreceptor, in a xerography, an electrostatic recording method, or the like.

(Prior Art)

It has been well known that an image is electrostatically formed on a photoconductive material for a development. US Pat. No. 2,297,691 discloses a basic xerography including: imparting a uniform electrostatic charge on a photoconductive insulating layer; forming an electrostatic latent image by exposing an image of light and shade on the layer and removing the electrostatic charge on a light image; and electrostatically adhering fine particles called as a toner on the image, thereby forming a toner image corresponding to the electrostatic latent image. This xerography further includes transferring the toner image on a surface of an image support like paper, and fixing the image by, for example, heating.

Some methods of adhering toner onto an electrostatic latent image to be developed have been known. Specifically, a method described in US Pat. No. 2,618,552 is known as a cascade development in which a developer material containing toner particles and particles called carrier having a relatively large diameter with respect to toner whose surface is covered with electrostatic charge, is allowed to pass across the electrostatic latent image for the

development.

In the method, the carrier particles are selected to allow triboelectrically charging to a desired polarity.

There is another method of developing an electrostatic charge image, for example, a magnetic brush development which is described in US Pat. No. 2,874,063. In this method, a developer containing toner and a magnetic carrier is supported by a magnet whereby the magnetic field of the magnet brings the magnetic carrier into alignment in a brush-like configuration, this magnetic brush is brought into contact with, or come close to the electrostatic latent image, and the toner is drawn from the brush to the electrostatic latent image by electrostatic attraction.

As to other methods, a liquid development as described in US Pat. No. 2,899,335, a fur brush development as described in US Pat. No. 2,902,974, a touchdown development as described in US Pat. No. 3,166,432 and the like are known.

A developed toner image is transferred by corona discharge on an image support such as paper. The transferred toner image is easily removed from the image support. Therefore, the transferred toner image has to be fixed on the support.

As a fixing method, a method of melting toner by heating, a method of dissolving toner with the use of a solvent, a method of plastically deforming a toner by

pressure, and the like are known. Of these methods, the method of fixing by heating, particularly, a method called heat roll fixing is most commonly employed because of its excellent energy efficiency, economic efficiency, high-speed fixability, and the like.

In the method of heat roll fixing, the heat rollers heated to a temperature in the range of usually from 150 to 220°C are used in practical, by reason of melting property of a binder resin in toner, economic efficiency such as electric power consumption, copy speed, or the like. The binder resin in a toner used for the method which has a low glass transition point or low molecular weight is preferable from the viewpoint of fixability. However, there is a problem from the viewpoint of storage stability of the toner if the glass transition point is set to be too low. Consequently, the temperature is limited to be over a certain level.

In addition, in the case of using a resin which has a low molecular weight, it is easy to cause a so-called offset phenomenon that a toner is transferred from an image support to a heated roller upon fixation and adheres thereto. Also, it becomes unfavorable from the viewpoint of mechanical strength of toner.

For reasons as mentioned above, there have been known some techniques of employing a binder resin which comprises

a resin having a specific degree of dispersion in regard to a molecular weight, a binder resin which comprises a resin having a low molecular weight and a resin having a high molecular weight, or a binder resin which comprises a crosslinked polymer.

Specifically, Japanese Unexamined Patent Publication No. S50-134652 discloses a method which employs a resin having a ratio of a weight average molecular weight to a number average molecular weight of 3.5 to 40 as a binder resin.

Japanese Unexamined Patent Publication No. S54-114245 discloses another method which employs: as a binder resin, a low molecular weight polymer having a molecular weight of 1,000 to 4,000 and a glass transition point of 40 to 60°C, which has low-temperature meltability and high flowability; and a high molecular weight polymer having a weight average molecular weight of 500,000 or more and a glass transition point of 35 to 60°C.

Japanese Unexamined Patent Publication No. S56-16144 discloses a method which employs a resin having at least one maximum value in each region of a molecular weight of 1,000 to 80,000 and a molecular weight of 100,000 to 2,000,000 in the molecular weight distribution measured by gel permeation chromatography.

The method described in each publication mentioned above aims to control an offset phenomenon while maintaining

fixability by including an uncrosslinked low molecular weight polymer and a high molecular weight polymer.

For example, Japanese Unexamined Patent Publication No. S49-101031 discloses a method which employs, as a binder resin, a vinyl-based polymer to which a crosslinking agent is added and reacted.

US Pat. No. 3,938,992 also discloses a method which employs a crosslinked polymer as a binder resin.

(Problems that the Invention is to Solve)

However, it had been common that the offset resistance is not sufficiently improved in a resin specifying only the degree of dispersion, and also that in the above binder resin containing a low molecular weight polymer and a high molecular weight polymer, uncrosslinked polymers are employed for each polymer and a molecularly interaction between the low molecular weight polymer and the high molecular weight polymer is caused, thereby limiting the fixability owing to the property of the high molecular weight polymer or insufficiently preventing the offset phenomenon owing to the property of the low molecular weight polymer.

In the case of employing a crosslinked polymer as a binder resin, the elastic property is so strong that fixability deteriorates. Particularly, in the case of fixing at high speed, the fixability becomes insufficient.

In addition, the mechanical strength is extremely high that grindability often deteriorates.

The present invention is made under the circumstances described above, and the object of which is to provide an electrophotographic toner having an excellent property of preventing an offset phenomenon in addition to a sufficient fixability, which is also excellent in storage stability and particularly suited for high-speed copying.

An another object of the invention is to provide an electrophotographic toner having excellent grindability and developability.

(Means for Solving the Problems)

The present invention relates to an electrophotographic toner which includes a binder resin comprising:

(a) 20 to 95% by weight of an uncrosslinked vinyl polymer having a weight average molecular weight of 10,000 to 50,000 and a glass transition point ranging from 40 to 80°C, and containing no gel fraction; and

(b) 80 to 5% by weight of a crosslinked polymer having a glass transition point ranging from 30 to 70°C and 5 to 70% by weigh of a gel fraction.

The uncrosslinked vinyl-based polymer of the invention is a polymer of one kind or copolymer of two or more kinds selected from monofunctional vinyl monomers. A mixture of such polymers may also be employed.

Herein, examples of the monofunctional vinyl monomer include styrene derivatives such as styrene, p-methylstyrene, m-methylstyrene, p-methylstyrene, and α-methylstyrene; monofunctional acrylic acid derivatives such as methyl acrylate, ethyl acrylate, propyl acrylate, butyl acrylate, hexyl acrylate, octyl acrylate, stearyl acrylate, lauryl acrylate, oleyl acrylate, cetyl acrylate, cyclohexyl acrylate, phenyl acrylate, benzyl acrylate, furfuryl acrylate, tetrahydrofurfuryl acrylate, glycidyl acrylate, hydroxyethyl acrylate, hydroxypropyl acrylate, hydroxylbutyl acrylate, (N,N-dimethylamino)ethyl acrylate, (N,N-diethylamino)ethyl acrylate, morpholinoethyl acrylate and piperazinoethyl acrylate; monofunctional methacrylic acid derivatives such as methyl methacrylate, ethyl methacrylate, propyl methacrylate, butyl methacrylate, hexyl methacrylate, octyl methacrylate, stearyl methacrylate, lauryl methacrylate, oleyl methacrylate, cetyl methacrylate, cyclohexyl methacrylate, phenyl methacrylate, benzyl methacrylate, furfuryl methacrylate, tetrahydrofurfuryl methacrylate, glycidyl methacrylate, hydroxyethyl methacrylate, hydroxypropyl methacrylate, hydroxylbutyl methacrylate, (N,N-dimethylamino)ethyl methacrylate, (N,N-diethylamino)ethyl methacrylate, morpholinoethyl acrylate and piperazinoethyl methacrylate; maleic acid derivatives such as maleic anhydride, maleic acid, methyl maleate,

dimethyl maleate, ethyl maleate, diethyl maleate, butyl maleate, dibutyl maleate, octyl maleate, dioctyl maleate, glycidyl maleate, diglycidyl maleate, N-methylmaleic imide, N-ethylmaleic imide, N-propylmaleic imide, N-butylmaleic imide, N-hexylmaleic imide and N-octylmaleic imide; vinyl monomers such as vinyl acetate and vinyl chloride; and the like.

For the uncrosslinked polymer, it is preferable that a polymer has a styrene content of 40% by weight or more because of the relation between melting viscosity behavior and a glass transition point, economic efficiency and the like which is a key factor for fixability.

With regard to the uncrosslinked vinyl polymer, employed ones have the weight average molecular weight of 10,000 to 50,000, preferably 20,000 to 40,000, in terms of polystyrene standard, in a molecular weight measurement by gel permeation chromatography. When the weight average molecular weight is less than 10,000, it becomes difficult to knead the polymer upon toner preparation, the durability deteriorates due to the mechanical strength poverty, and it causes fogging or scattering thereby decreasing the developability. Moreover, toner deteriorates an image by forming a film on a photoreceptor, that is, leads to filming. Besides, it is given to cause a cleaning defect of the photoreceptor. Further, when the weight average molecular

weight is more than 50,000, the fixability is insufficient.

With regard to uncrosslinked vinyl polymer, employed ones have the glass transition point of 40 to 80°C, preferably 50 to 70°C. When the glass transition point is lower than 40°C, the storage stability decreases. When the point is higher than 80°C, the fixability becomes insufficient.

For the invention, the glass transition point is measured by DSC. By taking alumina as a standard sample, an endothermic curve is measured by elevating the temperature of a specimen of almost the same amount to the alumina, at a rate of 20°C/min. In the absorption curve, the baseline (no endotherm) and the endothermic state line are extrapolated to set a glass transition point.

As the uncrosslinked vinyl polymer, a polymer containing no gel fractions at all is used. The gel fraction refers to a chloroform insoluble substance according to the invention. The chloroform insoluble substance is measured by adding about 1g of a specimen into chloroform, being allowed to stand still at room temperature for 3 days, passing through two kinds of paper filters in accordance with JIS-P 3801, washing insoluble substance with about 100g of chloroform three times, and thereby measuring insoluble dry weight to set a gel fraction in a specimen.

For the crosslinked polymer, a crosslinked vinyl

polymer which is obtained by copolymerizing a polyfunctional vinyl monomer with one or two or more kinds of monofunctional vinyl monomer(s) described above is used.

Examples of the polyfunctional monomer include bifunctional monomers such as divinylbenzene, ethylene glycol diacrylate, ethylene glycol dimethacrylate, propylene glycol diacrylate, propylene glycol dimethacrylate, butylenes glycol diacrylate, butylene glycol dimethacrylate, hexanediol diacrylate, hexanediol dimethacrylate, triethylene glycol diacrylate, triethylene glycol dimethacrylate, polyethylene glycol diacrylate, polyethylene glycol dimethacrylate, polypropylene glycol diacrylate, polypropylene glycol dimethacrylate, neopentyl glycol diacrylate, neopentyl glycol dimethacrylate, bisphenol A diacrylate, bisphenol A dimethacrylate and 2,2-bis(4-acryloxydiethoxyphenyl)propane; trimethylolpropane triacrylate, trimethylolpropane trimethacrylate, pentaerythritol tetraacrylate, pentaerythritol tetramethacrylate, and the like.

As the crosslinked polymer, a crosslinked polymer obtained by copoymerizing a monofunctional vinyl monomer with a polymer having two or more copolymerizable vinyl group(s) in a molecule such as unsaturated polyester and a terminal maleic acid modified acryl polymer, substances which is reacted an uncrosslinked polymer having a known

functional group crosslinkable by a crosslinking agent, or the like is employed. For the crosslinked polymer according to the invention, a crosslinked vinyl monomer which is obtained by copolymerizing and crosslinking a polyfunctional vinyl monomer is preferred because of simplicity upon preparation, stability, and light remaining amount of unreacted substance. Further, the crosslinked polymer preferably has a styrene content of 40% by weight or more for similar reasons to the uncrosslinked vinyl polymer.

According to the crosslinked polymer of the invention, the gel fraction, that is, chloroform insoluble in the above method of measurement is 5 to 70%, preferably 10 to 50% by weight. When the gel fraction is less than 5% by weight, the effect of preventing an offset phenomenon and the mechanical strength of toner deteriorate. In addition, the molecular compatibility with the uncrosslinked vinyl polymer is so high that the fixability deteriorates adversely. When the gel fraction is more than 70% by weight, the kneadability with the uncrosslinked vinyl polymer components, pigments, and other additives deteriorates remarkably, it causes scattering, fogging or the like, and the image deteriorates.

The glass transition point of the crosslinked polymer is 30 to 70°C, preferably 40 to 60°C in the above method of measurement. The storage stability deteriorates when the

glass transition point is lower than 30°C, the kneadability deteriorates and the strength of a fixed image also deteriorates easily when the point is higher than 70°C. The preferred glass transition point is the same with or approximately 5°C lower than that of the uncrosslinked vinyl polymer. This is because, in the case of a crosslinked polymer, the storage stability tends to improve than that of the uncrosslinked vinyl polymer having the same glass transition point.

The uncrosslinked vinyl polymer and the crosslinked vinyl polymer according to the invention are prepared by, for example, polymerizing according to well-known polymerization methods such as desolvation, suspension polymerization, emulsion polymerization and bulk polymerization after solution polymerization of a raw material monomer. Among them, suspension polymerization is preferred from the aspect of economic efficiency, handleability and the like. A lipophilic vinyl polymer is preferably employed as a binder of electrophotographic toner since the toner is required to have the stability to moisture. For such reason, concretely the polymers is preferably prepared by aqueous suspension polymerization with the use of a slightly soluble organic salt such as calcium phosphate and calcium carbonate, and a water-soluble high molecular polymer such as polyvinyl alcohol-polyvinyl

pyrolidone-poly(sodium acrylate)-poly(sodium methacrylate) as a dispersant.

The uncrosslinked vinyl polymer and the crosslinked polymer are blended in a weight ratio, uncrosslinked vinyl polymer/crosslinked polymer, of 20:80 to 95:5, preferably 40:60 to 80:20. In the case where the ratio is less than 20:80, the elastic property is so strong that the fixability, particularly fixability at high speed deteriorates. In addition, in the case where the ratio is more than 95:5, effect of the crosslinked vinyl polymer becomes poor, and effect of preventing the offset resistance is lowered, as well as reducing the mechanical strength.

Electrophotographic toner of the invention is allowed to contain a coloring agent and/or a magnetic powder.

Specific examples of the coloring agent include carbon black, nigrosine dye, aniline blue, alco oil blue, chrome yellow, ultramarine blue, DuPont oil red, quinoline yellow, malachite green oxalate, lamp black, rose bengal, and mixtures thereof. The amount of the coloring agent, though it differs from depending on materials for use, is preferably used in 3 to 20% by weight to the total toner content, but not limited thereto.

Examples of the magnetic powder include ferrite, magnetite and the like, and used in 30 to 60% by weight to the total toner content. When the magnetic powder is used

with a coloring agent, the amount of the coloring agent is preferably used in 10% by weight or less to the total toner content.

According to electrophotographic toner of the invention, other known additives can be arbitrarily employed. Concretely, low molecular weight polyethylene, low molecular weight polypropylene, long-chain fatty acid and esters thereof, derivatives such as an amide compound, waxes such as paraffin wax, castor wax, and carnauba wax can be employed as an improver for fixability or offset resistance.

Electrophotographic toner of the invention is prepared by arbitrarily known kneading methods. Among them, particularly those prepared by heating a binder resin to give a certain level of melting state, and mixing under mechanical shear force are preferable.

The method is exemplified by a method of passing the binder resin between two heated rollers, a method of stirring and mixing the resin by a heated screw, a method of ejecting a toner composition in a melting state through fine pores by pressure, or the like. The method is not limited as long as it has the same effect.

According to the invention, the uncrosslinked vinyl polymer and the crosslinked vinyl polymer have to be prepared separately, and then the polymers have to be mechanically melted and kneaded. In this case, coloring

agents and/or magnetic powders, and other additives may be existed at the same time.

The melt kneading of uncrosslinked vinyl polymer and crosslinked polymer is necessary so as to provide a so-called molecular 'micro-dispersion' and not 'compatibleness'. Consequently, there may be a difference in the way of kneading, but the melt kneading should either not be insufficient or not be too much. For the invention, particularly there is a limit for the gel fraction of crosslinked vinyl polymer. According to the use within such limited range, an object can be achieved by normal minimum kneading, that is, kneading required for uniformly dispersing a coloring agent such as a pigment and a dye. The coloring agents and/or magnetic powders and other additives may be kneaded with a binder resin after kneading like this.

For the invention, when melt kneading is insufficiently carried out, coloring agents and/or magnetic powders cannot be uniformly dispersed. As a result, phenomena such as toner scattering and fogging occur and the developability deteriorates. Meanwhile, when melt kneading is too much subjected, the uncrosslinked vinyl polymer and the crosslinked vinyl polymer are set to be in a molecularly 'melting' state, and the fixability, particularly fixability at high speed deteriorates. The optimal melting and

kneading differs from depending on kinds and blend of the polymers, kinds and blend of the additives, and a kneader, and is arbitrarily determined in each case.

For the invention, a toner composition which is suitably melt kneaded is pulverized into an average diameter of approximately 5 to 30 μ by a known method. In this case, all of the known mechanical pulverization means such as a hammer mill and jet mill can be employed. A pulverized toner can also be classified by a well-known method, if needed.

(Examples)

The present invention will be illustrated in detail with reference to Examples.

Hereinafter, the term 'part(s)' denotes 'part(s) by weight'.

1. Polymer Preparation

A cylindrical separable flask reactor equipped with a stirrer, a condenser tube, a nitrogen gas introducing tube, a thermometer and a temperature controlling detector, was charged with a mixture of 100 parts of 0.2% aqueous solution of partially saponified polyvinyl alcohol, vinyl monomers indicated in Tables 1 and 2, and a polymerization initiator benzoyl peroxide. The mixture was polymerized by heating while stirring at a temperature of 85°C for 6 hours,

subsequently at a temperature of 95°C for 2 hours under a nitrogen atmosphere. After cooling the inside of the reactor to 50°C, the polymerized mixture was filtered under reduced pressure. The obtained polymer beads were washed with 100 parts of tap water and filtered under reduced pressure. This operation was repeated five times. After washing, the obtained polymer beads were dried at 50°C in a drier for 24 hours. The properties of the obtained polymers are shown in Tables 1 and 2.

Furthermore, polymers obtained by specific blending as shown in Table 1 were uncrosslinked polymers, and polymers obtained by specific blending as shown in Table 2 were crosslinked polymers.

Table 1 Uncrosslinked Polymer

Type of Polymer		UC-1	UC-2	UC-3	UC-4	UC-5	UC-6
Monomer Composition	Styrene	80	70	70	80	80	70
	Butyl Acrylate	20	-	-	-	20	30
	Butyl Methacrylate	-	30	-	20	-	-
	Methyl Methacrylate	-	-	20	-	-	-
	Octyl Acrylate	-	-	10	-	-	-
Benzoyl Peroxide		4	4	4	4	1	4
Glass Transition Point (°C)		54	67	57	89	55	34
Gel Fraction (%)		0	0	0	0	0	0
Mw		32,000	36,000	38,000	31,000	62,000	37,000
Mn		14,000	16,000	17,000	14,000	28,000	15,000

Mw: weight average molecular weight

Mn: number average molecular weight

Table 2 Crosslinked Polymer

Type of Polymer		CL-1	CL-2	CL-3	CL-4	CL-5	CL-6
Monomer Composition	styrene	74.7	59.8	59.8	74.5	74.99	60
	Butyl Acrylate	25	-	-	25	25	40
	Butyl Methacrylate	-	40	20	-	-	-
	Methyl Methacrylate	-	-	20	-	-	-
	Divinylbenzene	0.3	0.2	-	0.5	0.01	0.3
	Hexanediol Dimethacrylate	-	-	0.2	-	-	-
Benzoyl Peroxide		2.0	2.5	2.5	2.0	2.0	2.0
Glass Transition Point (°C)		51	61	85	54	43	28
Gel Fraction (%)		48	36	30	93	3	35

Example 1

60 parts of uncrosslinked polymer UC-1, 40 parts of crosslinked polymer UL-1, 10 parts of Carbon Black, 3 parts of BONTRON E-81 (negative charge controlling agent, manufactured by Orient Chemical Industries, Ltd.), and 2 parts of low molecular weight polypropylene were mixed, and repeatedly kneaded five times with two rollers which had been heated to 100°C. The resultant product was coarsely grinded with a hammer mill, subsequently classified after grinding with a jet mill, and set to be a toner having an average diameter of about 13 μ. The toner was mixed to a toner concentration 5% with an iron oxide powder EFV 200/300 (manufactured by Nihon Teppun) as a carrier, so as to give a developer.

This developer was introduced to a developing machine

improved from copier NC3000 (manufactured by Copyer Co., Ltd.), and an unfixed image which was black solid in one third of A4 paper was prepared.

Then, a fixation test was carried out using a heated roller type fixation tester which includes Teflon in the upper part and silicon rubber in the lower part, by changing the roller temperature from 100 to 240°C in every 10°C and passing the image through the rollers whose linear velocity was 800 cm/min. The fixability was determined by putting a cellophane tape on a fixed image, loading 100 g/cm^2 thereon, slowly drawing back the tape, and measuring the image density (hereinafter, referred to as ID). The temperature of fixation completion was given when the ID ratio between before and after the tape peel test is 95% or more. Hereinbelow, results of the example which was compared with number of kneading with two rollers are shown in Table 3.

Table 3 Experimental Results

Number of Kneading	1	2	3	4	5
Blow-off Charge (μc/g)	18	22	24	25	26
Fixation Completion Temperature (°C)	140	130	120	130	140
Hot Offset Temperature (°C)	180	220	≥240	≥240	≥240

Here, ID of a part where a roller area that is in contact with the black solid part is re-contacting to the

void part was measured, and the lowest temperature at which ID is increased by 5% or more than those of other void parts is given as a hot offset temperature as in the above table.

Subsequently, continuous copy tests of 20,000 sheets were carried out under the conditions of using a toner in which the kneading number was 3 times, a temperature of 30°C, and a humidity of 80%, with the use of copier NC3000 (manufactured by Copyer Co., Ltd.). Fogging or the like did not appear, and the developability was extremely excellent. In addition, particle size distribution at the beginning and after 20,000 copies was checked to examine mechanical strength. As a result, fine particles having a diameter of 5 μ or less were increased only by 0.4 to 0.5% in approximate, and the mechanical strength was fully satisfied. Further, caking did not appear and the storage stability was excellent, although the toner was charged into a desiccator having a humidity of about 80% and left at a temperature of 50°C for 24 hours.

Examples 2 to 5

Experiments were carried out in the same manner as in Example 1, with the combination and blending amount of uncrosslinked polymers and crosslinked polymers, as shown in Table 4. The results are shown in Table 4.

Table 4 Blending and Experimental Results

	Example 2	Example 3	Example 4	Example 5
Blending Quantity of Uncrosslinked Polymer (part)	UC-2 70	UC-3 70	UC-2 70	UC-1 50
Blending Quantity of Crosslinked Polymer (part)	CL-2 30	CL-1 30	CL-1 30	CL-2 50
Optimal Kneading Number	2	3	3	2
Fixation Temperature (°C)	120	130	130	120
Offset Temperature (°C)	240	≥240	≥240	240
Blow-off Charge (μc/g)	27	24	28	26
20,000 Continuous Copy Test	Extremely Excellent			
*1	0.5	0.4	0.5	0.5
*2	0.7	0.5	0.6	0.7
Storage Stability	Excellent			

*1: Fine Particles Smaller than 5 μ at Beginning

*2: Fine Particles Smaller than 5 μ after 20,000 Copies

Comparative Examples 1 to 4

Experiments were carried out in the same manner as in Example 1, with the combination and blending amount of uncrosslinked polymers and crosslinked polymers, as shown in Table 5. The results are also shown in Table 5.

Table 5 Blending and Experimental Results

	Comp. Ex 1	Comp. Ex 2	Comp. Ex 3	Comp. Ex 4
Blending Quantity of Uncrosslinked Polymer (part)	UC-4 70	UC-5 50	UC-1 80	UC-6 60
Blending Quantity of Crosslinked Polymer (part)	CL-3 30	CL-5 50	CL-4 20	CL-6 40
Optimal Kneading Number	4	2	(5)*	2
Fixation Temperature (°C)	150	140	130	120

Offset Temperature (°C)	220	180	170	170
Blow-off Charge (μc/g)	23	27	28	26
20,000 Continuous Copy Test	Fogging occurs from about 10,000	Fogging occurs from about 10,000	Fogging occurs from Beginning	Toner Caking occurs
*1	0.4	0.5	0.5	0.5
*2	1.2	1.4	1.7	0.9
Storage Stability	Excellent	Caking occurs	Excellent	Complete Caking

*: In this case, an optimal kneading could not be found since the kneaded product was non-uniform. Accordingly, toner kneaded for 5 times was used in the test.

*1: Fine Particles Smaller than 5 μ at Beginning

*2: Fine Particles Smaller than 5 μ after 20,000 Copies

Comparative Example 5

The following tests were carried out to see the difference from 'compatibleness' in a molecular state, with respect to Example 1.

60 parts of an uncrosslinked polymer UC-1 was melted in 29.88 parts of styrene, 10 parts of butyl acrylate, and 0.12 parts of divinylbenzene, and 0.8 parts of benzoyl peroxide was added thereto. The mixture was polymerized in the same manner as for other polymers. A toner was prepared using 100 parts of the polymer in the same manner as in Example 1, and similar experiments were carried out. The results are shown in Table 6 together with the results of Example 1.

Table 6 Experimental Results

	Ex. 1	Comp. Ex 5
Number of Kneading	3	3
Fixation Temperature (°C)	120	140
Offset Temperature (°C)	≥240	≥240
Blow-off Charge (μc/g)	24	26
20,000 Continuous Copy Test	Extremely Excellent	
*1	0.4	0.4
*2	0.5	0.5
Storage Stability	Excellent	

*1: Fine Particles Smaller than 5 μ at Beginning

*2: Fine Particles Smaller than 5 μ after 20,000 Copies

From the test, it is found that the fixability in Example 1 is excellent when Example 1 and Comparative Example 5 (kneading number was 3 in either case) are compared.

[Advantage of the Invention]

The electrophotographic toner related to the present invention is excellent in fixability, hardly causes offset, and is excellent in durability and storage stability.

Applicant: Patent Attorney, Kunihiko WAKABAYASHI